

NAVAL BASE PHILADELPHIA-PHILADELPHIA NAVAL SHIPYARD,  
FOUNDRY/PROPELLER SHOP  
(Naval Base Philadelphia-Philadelphia Naval Shipyard,  
Building No. 20)  
League Island  
Philadelphia  
Philadelphia County  
Pennsylvania

HAER No. PA-387-0

HAER  
PA  
51-PHILA,  
709 Q -

PHOTOGRAPHS

Historic American Engineering Record  
National Park Service  
Department of the Interior  
P.O. Box 37127  
Washington, D.C. 20013-7127

ADDENDUM TO

HAER NO. PA-387-0

NAVAL BASE PHILADELPHIA-~~PHILADELPHIA~~ NAVAL SHIPYARD,  
FOUNDRY/PROPELLER SHOP

(Naval Base Philadelphia - Philadelphia Naval Shipyard, Building No. 20)

North of Porter Avenue, west of Third Street West

League Island

Philadelphia

Philadelphia County

Pennsylvania

HAER  
PA  
51-PA-LA  
7090-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN BUILDINGS SURVEY

National Park Service

Philadelphia Support Office

U.S. Custom House

200 Chestnut Street

Philadelphia, PA 19106

HISTORIC AMERICAN ENGINEERING RECORD

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Location: North of Porter Avenue, west of Third Street West,  
League Island, Philadelphia, Philadelphia County, Pennsylvania.

UTM: 18/474842 E. 4415699 N  
USGS Quadrangle: Philadelphia, Pennsylvania, 1:24000

Dates of Construction: 1917-1919

Engineers: F. R. Harris, Chief Engineer, Bureau of Yards and Docks, Department of the Navy.

Contractor: Warren, Moore, & Co., Philadelphia, Pennsylvania.

Present Owner: Commander, Norfolk Naval Shipyard, Portsmouth, Virginia.

Present Occupants: Norfolk Naval Shipyard Detachment Propeller Facility.

Present Use: Propeller foundry and precision casting shop.

Significance: Built as part of the Navy's vast expansion to meet the projected needs of World War I, Building No. 20 became the U.S. Navy's sole production facility for propellers. During World War II the facility produced over 5,500 propellers of various sizes and today continues to provide propellers and precision castings for the Navy's nuclear fleet.

Project Information: The exterior of Building No. 20 is proposed for renovation because the current wall cladding is spalling off. The current roof leaks, requiring replacement as well. The Pennsylvania State Historic Preservation Office determined that the proposed renovation would adversely effect the historic integrity of the structure. As mitigation, documentation of the structure was performed prior to renovation.

Steven Bedford Ph.D., TAMS Consultants Inc., September 1996

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**Summary Description Of Building No. 20 And Its Setting**

Building No. 20 measures 651'-0" x 182'-0" x 99'-0", and is located in the heart of the industrial area of the Philadelphia Naval Shipyard in Philadelphia, Pennsylvania. Abutting the building to the north is Building No. 1029, a modern machine shop where the propellers cast in Building No. 20 are machined to their final form. To the east and west are large concrete-framed industrial buildings, while to the south are Dry Dock No.3 and several multi-story concrete-framed industrial buildings.

The foundation for Building No. 20 is comprised of twenty-two bays of concrete piers consisting of stepped or conical concrete footings resting on wooden piles. The footings extend approximately 12' below the level of the floor. I-beam grillages were placed atop the largest footings—those in the central bay of the building that would eventually support cranes and major portions of the building.

The superstructure of the building is in the form of three long bays, with the central bay the tallest. The side bays are approximately 36' high, and the central bay reaches a height of 99'-0". Above the side bays the walls slope upward to meet a shallow V-shaped roof. Several one story, shed-roofed structures have been appended to the southern side of the building.

The basic structural system for the superstructure of Building No. 20 consists of twenty-two bays of steel frames, consisting of built-up steel columns connected by Warren trusses with verticals. The columns in the side bays were constructed from channel sections, while the columns in the central bay are built up from a variety of standard steel shapes. In the lower bays the trusses have been augmented by steel beams. These frames run transverse to the length of the building. Slanting upper walls, which form the exterior of the central bay, are supported by tapering Warren trusses with verticals, and the roof of the central bay is supported by shallow, V-shaped Warren trusses which actually rest on top of the columns of the central bay.

Longitudinally the building is tied together by Warren trusses linking the central columns at the top and mid-points of the columns. Further horizontal and vertical rigidity is added by an extensive system of diagonal bracing throughout the structure. The vertical bracing is found along each column line and along the outside walls, while the horizontal bracing connects the roof trusses in each of the three bays. Three crane rails and their supporting girders, located at various heights, provide further longitudinal connections in the central bay. Single crane rails and girders run the length of each of the two lower bays.

Originally, a mezzanine, supported by steel I-sections and used as a charging floor for a series of cupola furnaces, was located in the northeastern half of the northern bay. This area has now been enclosed and the lower level serves as offices for the propeller shop.

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The exterior of the building is clad in steel sash, some of which pivots; hollow terra cotta tile plastered over with cement stucco; and corrugated, wire safety glass. The exterior walls are topped with concrete coping. The exterior cladding is attached to the structure by a series of steel beams, brackets, and trusses that are directly connected to the wall columns or roof trusses. The sash and the tile appear to rest directly on the lower flanges or chords of the horizontal supports. In areas where there are large expanses of sash, vertical steel purlins were added for further rigidity and support. The purlins were riveted to the exterior beams or trusses midway between the columns. On the north facade a crane rail remains from the time that this area was used as a materials handling yard.

The roofs now consist of reinforced gypsum slab. Originally topped by asbestos roofing, the roof is now covered by built-up asphalt. Large ventilators project through the roof in various locations. Due to the poor condition of the roof deck, much of the roof and its supporting structure is covered in netting to protect the workmen from injury from falling objects.

Currently metal alloys, primarily brass-aluminum, are smelted in a modern furnace in the western end of the central bay, while sand for casting molds is prepared in the eastern end of the same bay. The sand itself is stored in a large silo outside the eastern end of the building. The molds for large castings, such as propellers, are formed in a series of 20 square foot pits in the middle of the central bay. Using the overhead cranes, molten metal is transported in large ladles for pouring into the molds. Once removed from the mold and cooled, the casting is moved by crane to Building No. 1029 to be machined to its final shape. Smaller castings that do not require placement in large pits are created in a similar manner in the south bay of the building. Equipment for machining those parts is also located in the southern bay.

## History

Since the Philadelphia Naval Shipyard's was conceived as an "iron ship-building" yard, it is not surprising to learn that Building No. 20 is not the first foundry there. At least one, Building No. 17 (1908), preceded it and is now used as a winch factory. However, the genesis of Building No. 20 lies in the state of the U.S. Navy in 1916. As World War I progressed into its second full year, the Navy, realizing that it soon would be forced into the war, embarked on the development of a six-year building program with war preparedness as the paramount issue. On May 2, 1916 the Secretary of the Navy Josephus Daniels appointed the Board for the Development of Navy Yard Plans "to draw up for consideration by the bureaus [of the navy] and for his approval a plan for each navy yard."<sup>1</sup>

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<sup>1</sup>U.S. Bureau of Yards and Docks, *Activities of the Bureau of Yards and Docks, World War 1917-1918*, (Washington: GPO, 1921): p. 129.

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The board was instructed to:

prepare...a comprehensive plan of development embodying the requirements of the base plan and the essentials of an ideal layout so far as same may be practicable for the station under consideration.<sup>2</sup>

Under the guidance of the representatives of the bureaus of Yards and Docks, Steam Engineering, and Construction and Repair, an ideal plan for a navy yard was developed. Known as the "type plan," it called for shipbuilding activities at one end of the waterfront and dry docks at the other. Industrial buildings such as foundries, structural shops, machine shops, warehouses, and woodworking facilities were to be laid out between the dry docks and shipways on a main waterfront street connecting the shipbuilding area with the dry dock area. With this ideal plan in mind, the board then proceeded to develop plans for each of the Navy yards.

After devising a plan for the shipyard at Norfolk, the board then took up the plan for Philadelphia. More than twenty plans were developed before a final scheme was agreed upon. After a few more modifications, the plan was submitted to the Secretary of the Navy, who gave it final approval on May 1, 1917. Subsequently, plans for new buildings including the structural shop, power house, and foundry were developed. Located in the center of the shipyard just north of the dry docks and ship building ways, their placement clearly conformed to guidelines developed in the ideal plan.<sup>3</sup>

Since it was envisioned that more than one foundry would be built during this period of industrial expansion, the Bureau of Yards and Docks also developed standardized plans for navy yard foundries. The standard foundry plan was described as follows:

The typical foundry building comprises a high center aisle, 80 feet wide; two lower side aisles, one of 55 feet width with a mezzanine floor, and one of 45 feet width; and a 100-foot material and flask yard adjacent to the latter.

The material yard is served by an overhead traveling crane of 10 tons capacity and 40 feet lift. The adjacent side aisle, into which materials are moved from the open yard, or from bins opening directly into the foundry, is of one story for the greater part of its

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<sup>2</sup> Ibid.

<sup>3</sup> Op.cit., p. 130.

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length, 32 feet high to the bottom chords of roof trusses. This aisle contains the cupolas and the various converters, furnaces, etc. At the cupolas a second floor is provided for charging, with an intermediate floor to house the blowers for the cupolas. The single story portion of the side aisle is provided with 2-ton and 5-ton traveling cranes. The center (main) aisle, in which the large castings are molded. Poured and handled, is 75 feet high to the bottom of roof trusses, and is provided with three tiers of cranes—an 80-ton bridge crane of 63 feet lift, two 15-ton cranes of 50 feet lift and two traveling wall cranes of 5 tons capacity on each side of the aisle. The 55-foot side aisle, with a gallery floor 22 feet above the main floor houses molding machines, crucibles, cleaning and grinding apparatus, etc., and is served generally by monorail cranes of ½-ton capacity and by 2-ton traveling bridge cranes.<sup>4</sup>

Two foundries of this type were built – a 408'-0" long version in Norfolk, and a 651'-0" long one in Philadelphia (Building No. 20). Both buildings were designed and located for extension to an ultimate length of 1,000' long. Plans were completed in December 1917 and construction for the Philadelphia foundry began in early 1918. Building No. 20 was constructed by Warren, Moore & Co. of Philadelphia. The company was selected before building design using a unit pricing method. In the Navy's official reports, the actual cost of the building was lumped in with all projects underway at the navy yard during the war, making it impossible to determine the final cost of the building.<sup>5</sup>

The foundry at Philadelphia also differed from Norfolk in its external appearance. It was initially planned to be located further east, behind the existing foundry. However, this would have limited its maximum size and the location was changed to further west, just north of Dry Dock No. 3. On the recommendation of "yard officials," in an effort to improve lighting and ventilation, the side walls of the main bay were inclined and clad with steel sash and glass, and continuous top-hung ventilation sash was installed in the upper portion of the walls.<sup>6</sup>

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<sup>4</sup>Op.cit., p. 169

<sup>5</sup> Ibid. and drawing E-2105, "Scale of Offers . . . for Foundry Building," June 11, 1917, Public Works Center (former) Philadelphia Naval Shipyard.

<sup>6</sup>Ibid.

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The exterior structure was not completed before the end of the war, and the initial floor plans for the building show only the location of four cupola furnaces. Before completion additions to the building were already being made. Large covered storage bins were added to the north side of the building, beneath the material yard craneways. Offices were inserted in the southern aisle.

Since the building was not completed until after World War I, its immediate future was uncertain, but soon Building No. 20 was developed as the Navy's sole supplier of large cast propellers, with equipment and casting pits large enough to produce a propeller approximately 20' in diameter and weighing 43,000 pounds.<sup>7</sup> This specialization meant the addition of reverberatory and electric induction furnaces. These were placed at the western end of the building. One-story additions, providing more storage space, molding space, and offices, were built along the southern side of the building during the inter-war period.<sup>8</sup>

From its inception, the roof of Building No. 20 has always been a problem. It originally consisted of a reinforced, poured gypsum deck topped by asbestos roofing. Installed in July and August 1918, by March 1919 there were twelve serious cracks in the roof. The gypsum deck cracked first, which, in turn, ruptured the waterproofing above. After almost two years of investigation, it was determined that the cracks were caused by a combination of the normal movement of the building's steel frame in response to seasonal temperature swings coupled with the intense heat produced by the foundry. Apparently insufficient expansion control joints had been placed while the gypsum deck was poured. Eventually control joints were placed in the deck and a built-up asphalt roofing material replaced the asbestos roofing.<sup>9</sup> It still leaks.

The earliest surviving equipment plan, dating to 1942, gives a clear image of the interior arrangement during World War II, the period of Building No. 20's greatest productivity, when over 5,500 propellers of varying sizes were produced. Adjacent to the north facade was the materials yard with its overhead crane. In the middle of the yard was an additional casting room with furnace. Appended to the north facade were storage areas for raw materials as well as locker rooms

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<sup>7</sup>E. S. McCawley, "The War History of the Fourth Naval District," Typescript on file at the Naval History Center, Washington, Navy Yard: Vol. 3, p. 90.

<sup>8</sup>See drawings and microfiche on file at the Public Works Center, (former) Philadelphia Naval Shipyard (hereafter, PWC).

<sup>9</sup>United States Bureau of Yards and Docks "Service of Gypsum Roofs on Navy Yard Structures, Philadelphia, Pennsylvania," *Public Works of the Navy* 32 (April, 1923): 44-54.



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and showers. The eastern third of the north and center aisles was devoted to iron and steel casting and to heat treatment furnaces. The western two-thirds of the center and main aisles were devoted to casting pits, furnaces for propeller production, and flask storage and ladle cleaning and repair areas. The western section of the southern aisle was devoted to areas for the creation of molds and the casting of small items. The eastern section was used primarily for final shaping of the casting and was filled with grinding, cutting, and sand blast machinery. The southern additions to the building were used for material storage, the creation of small molds, and locker rooms.<sup>10</sup>

Building No. 20 retained the aforementioned layout and general shape throughout World War II. After the war, Building No. 20 continued in its primary mission as the sole Navy source for propellers, particularly for nuclear submarines. Due to the importance of this manufacturing process to national security, little information on the process and changes in the foundry is available. However, over time, the steel and iron casting facilities were removed to be replaced by large machinery used in the sand molding process. Cranes and furnaces were also replaced during periodic modernizations. A silo for housing casting sand was built adjacent to the east facade. In 1979, Building No. 1029, where most of the machining of large castings occurs, was built in the materials yard to the north of Building No. 20. It connects directly with Building No. 20 via the north aisle.

The initial design of Building No. 20 is one of the earlier designs of the Bureau of Yards and Docks under the administration of Rear Admiral Frederick R. Harris (1874-1949). Born in New York City, Harris received his degree in mechanical engineering from Stevens Institute of Technology in 1896. In 1903 Harris was commissioned a lieutenant in the Civil Engineer Corps of the Navy, and until 1915 he held a variety of engineering positions in the Navy at the Charleston, New York, Philadelphia, Pearl Harbor, and Guantanamo bases. In 1916 he was appointed Chief of the Bureau of Yards and Docks of the Navy, and Chief of Civil Engineers, with the rank of Rear Admiral. In charge of all public works for the Navy during the early part of World War I, Harris was awarded the Navy Cross for his work. In late 1917 he was made general manager of the Fleet Emergency Corporation. In 1918 Admiral Harris was appointed president of the Board of Control of War Construction Activities at Hampton Roads Virginia. In 1927 he retired from the Navy, forming F.R. Harris Inc., consulting engineers.

During World War II Harris and his company pioneered the use of the tremie concrete method for building large dry docks and also designed the world's largest floating dry docks. Capable of lifting 100,000 tons and following the fleet, the dry docks were of tremendous value in the Pacific. After World War II Harris served on the engineering board of Port of New York Authority and became

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<sup>10</sup> McCawley, op.cit., p. 90 and drawing B3701, PWC.

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the chairman of the boards of consultants of the Newark and La Guardia airports.<sup>11</sup>

### Significance

Although large and vast, the significance of Building No. 20 is not based on the building's exterior or structure. The building was built using standard construction techniques of the period. It is the fact that, as part of the Philadelphia Naval Shipyard, Building No. 20 is emblematic of the rise of American industrial power during both world wars, and that the products of Building No. 20 – the propellers – were crucial to the development of American sea power, that makes Building No. 20 significant.

### Sources of Information/Bibliography

#### A. Engineering Drawings

Microfiche copies of original drawings are available on engineering document cards currently housed in the plan room at the Philadelphia Naval Business Center, Public Works Center Detachment, Philadelphia, Pennsylvania. Duplicate copies of these microfiche copies are also available at the offices of TAMS Consultants, Inc. in New York City. A list of available drawings is provided below:

<u>Drawing Number</u>	<u>Drawing Title</u>
E-2105	"Scale of Offers . . . for Foundry Building," 1917.
D2181	Foundry Location Plan, 1917.
B2145	Foundry Elevations, 1917.
B2142	Foundry Floor Plan, 1917.
B2144	Foundry Roof Plan, 1917.
B2145	Foundry Gallery Floor Plan and Transverse Sections, 1917.
B2146	Foundry Longitudinal Sections, 1917.
C1201	Foundry Transverse Sections, 1917.
B2148	Foundry Layout at Cupolas, 1917.
B2149	Foundry Revised layout at Cupolas, 1917.
B2147	Foundry Location Plan and Typical Footings, 1917.
B2003	Foundry Offices, Storeroom, Blower Room and Relocation of Relief Annex Building, 1917.

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<sup>11</sup> "Admiral F. Harris dies at age 74," *New York Times*, July 21, 1949.

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<u>Drawing Number</u>	<u>Drawing Title</u>
E2093	Foundry, Reinforcing in Casting Pits, 1918.
D2000	Foundry, Foundation for Cupolas, 1917.
D2026	Foundry, Foundation for Cupolas, 1917.
C3666	Foundry, Material Bins, South Side, Plans and Sections 1920.
B3098	Foundry, Triple 20'-0" x 20'-0" Casting Pits, Plans and Details, 1941.
B3237	Foundry, Ventilation, 1922.
C12974	Foundry, Exhaust Ventilating Fan Housings on Roof, Plans Elevations and Sections, 1942.
C13491	Foundry, Office-Core Room And Sand Storage Addition to South Side, 1942.
C7627	Foundry, High Frequency Induction Furnaces, Plan of Generator Room and Furnace Foundations, 1939.
C10277	Foundry, Arrangement of brass sand and Mold handling Equipment, 1943.
D6106	Foundry, 50 Ton Ladle, 1941.
D5687	Foundry, Foundation Plan for Core oven FK-11, 1942.
B3701	Foundry, Arrangement of Equipment Plans, 1942.
B3773	Foundry, Reverberatory Furnace, Plans And Stack Arrangement, 1942.
D8675	Foundry, Preliminary Plan of Proposed Additions, Plan of Office Equipment, 1942.
D5479	Foundry, Proposed 3 ton Electric Furnaces, Location Plan, 1939.
C9061	Foundry, Foundation Plans for Reverberatory Furnaces and Ladle Pit, 1939.

B. Historic Views

Historic views of the Philadelphia Naval Shipyard are on file at the Mid-Atlantic Regional Office of the National Archives in Philadelphia, Pennsylvania.

C. Interviews

McLaferty, Frank, Propellor Shop Supervisor, Philadelphia Naval Shipyard, Philadelphia, Pennsylvania. Telephone interview by author, October 1996.

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Luce, CDR. G., Ehrman, LT. K. S., and Landwehr, LT. C. E. "Historical Narrative, Public Works Division." 1946, Unpublished manuscript, Office of Naval History, Washington, D.C.

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"Admiral Harris Dies at Age of 74," *New York Times*. July 21, 1949, p. 25.

United States Bureau of Yards and Docks. *Activities of the Bureau of Yards and Docks, Navy Department, World War 1917-1918*. Washington: Government Printing Office, 1921.

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E. Likely Sources Not Yet Investigated

Daily Correspondence Files, Philadelphia Naval Shipyard, located at the National Archives, Mid-Atlantic Regional Office, Philadelphia, Pennsylvania.